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Language Networks in English-Spanish bilinguals with and without aphasia

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Introduction

Recent functional neuroimaging studies in bi- and multi-lingualism converge on the observation that the same core set of brain regions subserve all languages, irrespective of proficiency (Sebastian, Laird, & Kiran, 2011) but that language proficiency is a critical variable. The nature of language networks in individuals with bilingual aphasia has been less studied (Abutalebi, et al.,2009; Sebastian, Sandberg, & Kiran, 2012) but has high potential for clinical impact. In this study, using fMRI and DCM, we examine language networks in normal Spanish-English bilinguals and in individuals with bilingual aphasia.

Methods

Four Spanish-English speaking non-brain damaged bilinguals (NBB) and four chronic bilingual adults with aphasia (BAA) participated in the study. All participants were bilingual English-Spanish speakers and exposed to both languages before age 5. Patients experienced a single, unilateral ischemic stroke in the distribution of the left middle cerebral artery. Word triplets in English or Spanish were presented one at a time and participants were required to match the target on the top to the word most similar in meaning from the bottom. In the size judgment task, stimulus triplets consisting of consonant letter strings were presented, and participants were required to match the target on the top most similar in size to two options at the bottom. MR images were acquired at Boston University's Center for Biomedical Imaging on a 3T Phillips scanner. T1 images were acquired with the following parameters: 140 sagittal slices, $1mm^3$ voxels, TR=8.2ms. BOLD images were collected using the following parameters: 31 axial slices, $3mm^3$ voxels, TR=2s. MR data was analyzed in SPM8. Structural images were coregistered to pre-processed functional images and both were normalized to the MNI template. Lesion masks were drawn in MRIcron on each patient's T1 image and were used in normalization to minimize deformities during warping (Brett et al., 2001).

Results

The NBB demonstrated activation which included LIFGtri, RSFG, RMFG that was active for both English and Spanish, LMFG and left LMTG for only English stimuli and RIFGtri and RIFGorb and LPCG (precentral gyrus) for only Spanish stimuli. Voxel of interest (VOIs) for the effective connectivity analysis were created by constructing a 5 mm sphere around the peak activation voxels elicited during the semantic task using DCM in SPM8. For NBB, LIFGtri was the common strongest node for English and Spanish in addition to LMTG (English) and LPCG (Spanish) (see Figure 1). All three BAA demonstrated activation in LIFGtri and LPCG for Spanish stimuli, whereas activation for

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English was less consistent across patients (2/3 show activation in LMTG and LMFG).

Conclusions

Results identify core language regions (LIFGtri, LPCG, LMTG) that are differentially involved during processing of English and Spanish language in normal bilinguals and appear to be engaged even in bilingual individuals with aphasia. Results are discussed in the context of language proficiency and language impairment in post-stroke aphasia.

References

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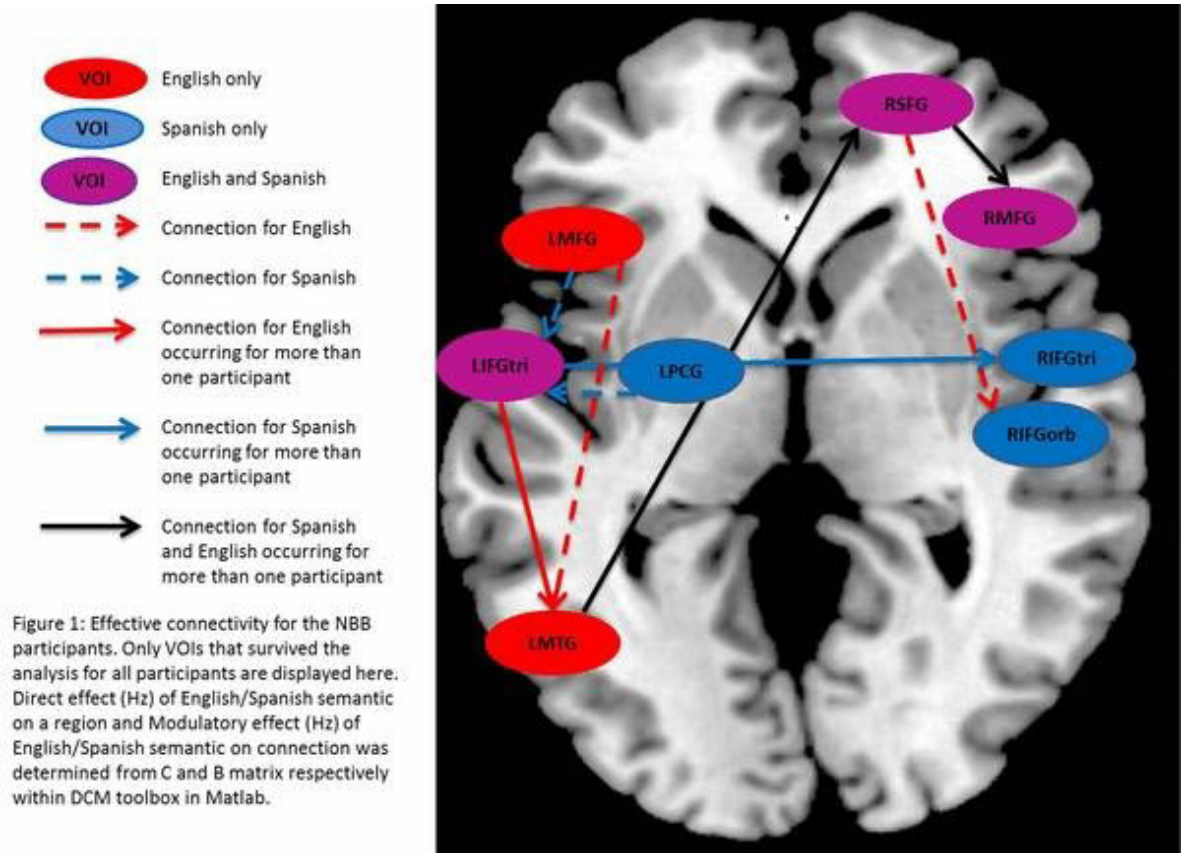

Figure 1: Effective connectivity for the NBB participants. Only VOIs that survived the analysis for all participants are displayed here. Direct effect (Hz) of English/Spanish semantic on a region and Modulatory effect (Hz) of English/Spanish semantic on connection was determined from C and B matrix respectively within DCM toolbox in Matlab.